ABSOLUTE DC POWER SUPPLY

MODEL NO. 30B-100

30B-100/30C-100/30F-100

ELECTRONICS FOR COMMUNICATION • MEASUREMENT • CONTROL

5725 KEARNEY VILLA ROAD • SAN DIEGO 12, CALIFORNIA • BR 7-6700

KAY LAB

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KAY LAB will periodically issue change sheets to technical manuals. These may be found attached to the manual upon receipt or received through the mail.

Please make the necessary changes and record on this form. The originial change sheet may then be thrown away. The number of the last effective change at the time of issuance will be found at the botton of this form.

Changes subsequent to the date of issuance may be made. The number of the last effective change can be obtained by writing to the Graphic Arts Department, KAY LAB, 5725 Kearney Villa Road, San Diego 11, California.

MODEL NO. 30B-100

Change No.	Title	Initial

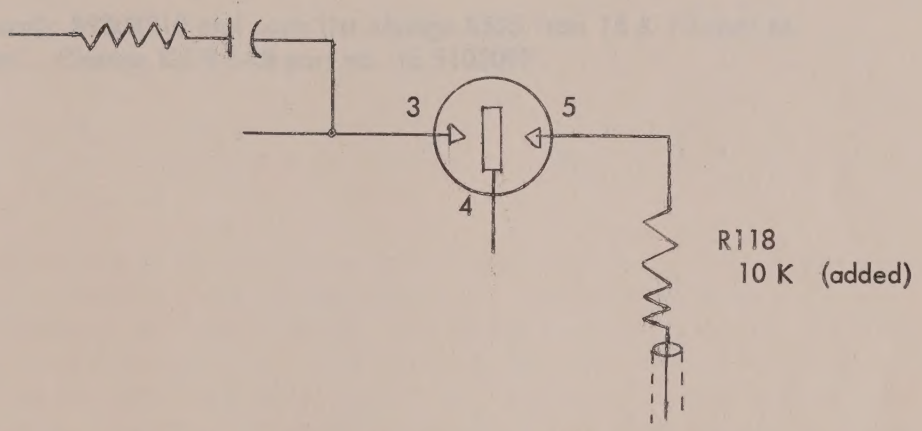
Number of last change applicable to this manual 2.

CHANGE NO. 1

ALL POWER SUPPLIES and M30B-1Z TECHNICAL MANUALS

Change Schematic as follows:

(1) Add R118 to all chopper amplifier sub-assemblies as shown below:



(2) On all fixed voltage power supplies, delete connection from positive terminal of BT401 to end of R402. Center arm of R402 remains connected as shown.

KAY LAB
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CHANGE NO. 2

30B-100 and 30F-100 Technical Manuals

Make the following changes, record on "Change Sheet" and dispose of this sheet.

Effective on units having serial numbers 2865, 2866, 2867, 2869 and on:

On Schematic B9803910 and parts list change R525 from 15 K 10 watt to 7K 20 watt. Change KAY LAB part no. to 5102097.

12/19/56

SECTION I

GENERAL DESCRIPTION

The KAY LAB Absolute DC Power Supply is essentially a high voltage, high power standard cell. Its long and short time stability is very nearly that of a laboratory standard cell. The direct-reading, accurately calibrated voltage-setting dials provide rapid adjustment over a wide range of voltages without the inconvenience of constant measurement. Because of the high accuracy and resolution of the voltage setting, only an external null indicator is needed to make the instrument uniquely useful as a wide range null-type DC voltmeter.

There are three features of this instrument which make it especially useful for the simultaneous operation of several multi-staged amplifiers. First and most important is very low internal impedance not only at DC but over a wide range of frequencies. This reduces inter-action between circuits. Secondly, very low hum and noise permit direct operation of high gain amplifiers without additional filtering which often presents low frequency problems. Thirdly, high current capabilities, both steady-state and transient, facilitate operation of pulse and power amplifiers. Combining more than one supply in plus-minus arrangements makes an ideal system for powering high gain DC amplifiers, such as those used in computers.

SPECIFICATIONS

VOLTAGE RANGE: 300 volts max. to 1.02 volts min. variable in steps of one volt and between steps with a potentiometer having a range of one volt ±2%. Although uncalibrated, the accuracy of the potentiometer is normally better than one scale division.

OUTPUT CURRENT: Zero to 1000 ma. DC at all output voltages and line voltage from maximum to minimum.

ACCURACY OF VOLTAGE SETTING: ±.02% or 5 millivolts, whichever is greater, on all switch selected outputs with potentiometer at maximum counter-clockwise position. Calibration is in absolute volts and maintained with reference to the internal standard cell. Normal variations of the standard cell with extremes of temperature or other causes will appear as constant percentage drifts in output voltage. These variations are normally less than 0.005%.

STABILITY: The output voltage variation is less than 0.01% for line voltage change from minimum to maximum. The variation in output voltage with changes in load current is defined under Output Impedance. Long time drift in output voltage does not exceed 0.01%. Short time drift is generally less than 0.005%.

OUTPUT IMPEDANCE: The effective impedance looking back into the power supply terminals is defined as the ratio of the change in output volts due to a given change in output current to the output current change. For DC, the output impedance is always less than 5 milliohms, and is generally less than 1 milliohm. Hence, the variation in output voltage for load changes is usually negligible. These supplies have a very low output impedance as a function of frequency, resulting in fast response to load transients and excellent isolation between loads connected to a single supply. The output impedance remains below 0.1 ohm to about 10,000 cycles, then rises to 0.5 ohms or less than 200 kc. In using this supply, it should be remembered that this low impedance is at the terminals of the supply. The impedance of ordinary connecting lines is usually much higher than the supply impedance, particularly at high frequency. For critical applications, very heavy coaxial line with low residual series inductance and resistance is useful.

OUTPUT HUM AND NOISE: The output contains chiefly 60 cycles and its harmonics with some high frequency noise present. When the supply is properly adjusted, the RMS value of this hum and noise is less than 0.5 millivolts, and frequently is as low as 0.1 millivolt. See Section IV, Adjustments, if the hum is higher than 0.5 millivolts.

TRANSIENT RESPONSE: This is the time necessary to recover from a large step current change. For step changes from half load to full load the recovery time is approximately 0.2 milliseconds.

*BIAS SUPPLY : 0 to minus 150 volts adjustable with a potentiometer. The positive side of the bias supply is connected internally to the negative terminal of the main power supply. Maximum current output of the bias supply is 5 ma.

*FILAMENT SUPPLY: An independent, 6.3 volt center-tapped filament winding is provided. Maximum current available is 10 amps. This winding is not connected to any portion of the power supply circuit.

LINE VOLTAGE: Normally 115 volts, 60 cycles at 8.5 amps. maximum. Allowable variation is 105 to 125 volts under all voltage and output current conditions.

*Not available on some models.

SECTION II

OPERATING INSTRUCTIONS

READ THIS SECTION BEFORE TURNING ON THE SUPPLY

PRELIMINARY NOTES:

1 When the supply is first received, lift the top cover and remove all packing material from the chassis and components. Failure to do this may result in over-heating. Examine carefully for tubes which may be broken or out of their sockets.

2 Either the "+" or the "-" terminal must be strapped to the "G" terminal at all times, depending upon whether a positive or a negative output voltage is desired. On fixed voltage supplies, the strap is connected internally between the appropriate terminals.

3 If this supply uses mercury-vapor rectifiers, it is necessary to pre-heat them before using the supply for the first time. Remove the plate connectors from the rectifiers and the chopper (D101) from its socket. With the supply in its normal vertical position, operate for approximately one-half hour. Then shut off and restore plate connectors and chopper. Be sure to use the chopper clamp as provided. Unless the mercury-vapor rectifiers are subsequently inverted, it will not be necessary to repeat this procedure.

4 WARNING! If the supply in inoperative, DO NOT switch below 100 volts. On fixed-voltage supplies, turn off and ascertain the fault (See Section V, Trouble Shooting).

5 WARNING! The standard cell is mounted vertically and this position must be maintained when the supply is in operation.

6 The 0-150 volt bias output is connected internally to the "-" terminal.

CONTROLS:

"AC-ON": This switch controls all power to the supply. The amplifier power supply is switched directly, and the primary supply for the output power is controlled through a time delay system. When switched to "ON", the left indicator lamp should light immediately. After a warm-up period of approximately one minute, the supply is completely operative.

"DC-ON": This switch controls a relay which in turn switches the output power and voltage-sampling leads. When switched to "ON", the voltage is immediately available at the output terminals, and the right indicator lamp lights.

VOLTAGE DIALS:
(for variable voltage supplies)

The voltage to which the instrument is set is indicated by the summation of all the dial readings. For example, to obtain 208 volts on a four-dial power supply, set the 100's dial to 100, the 10's dial to 100, the 1's dial to 8, and the potentiometer dial to 0, as shown in Figure 2.1.

The output voltage of three-dial supplies is similarly the sum of the three dial readings.

OPERATING PROCEDURE:

1 When turning on the instrument for the first time, connect a voltmeter to the output terminals to insure that the unit is operating properly and has not been damaged in shipment. Since the unit contains a standard cell, up to eight hours may be required to stabilize the unit after shipping or severe handling.

2 Likewise, if the unit has been stored, allow it to operate for two hours before using it. The last two conditions apply only when the unit is being used for measurements requiring an accuracy greater than 0.1%.

3 When the power supply is used in conjunction with other equipment, it is desirable to turn on the "AC" switch first and allow approximately two minutes for the unit to stabilize.

4 A voltmeter may be connected across the "OUTPUT" terminals when the "DC" switch is turned on in order to insure proper operation and prevent damage to either the power supply or the associated equipment.

5 It is advisable to set the voltage dials above 100 volts until certain the supply is functioning properly. Normal starting transients will not affect the supply. However, in the event of complete failure which might cause the output voltage to go very high, the precision attenuator may be damaged if the voltage dial is set below 100 volts.

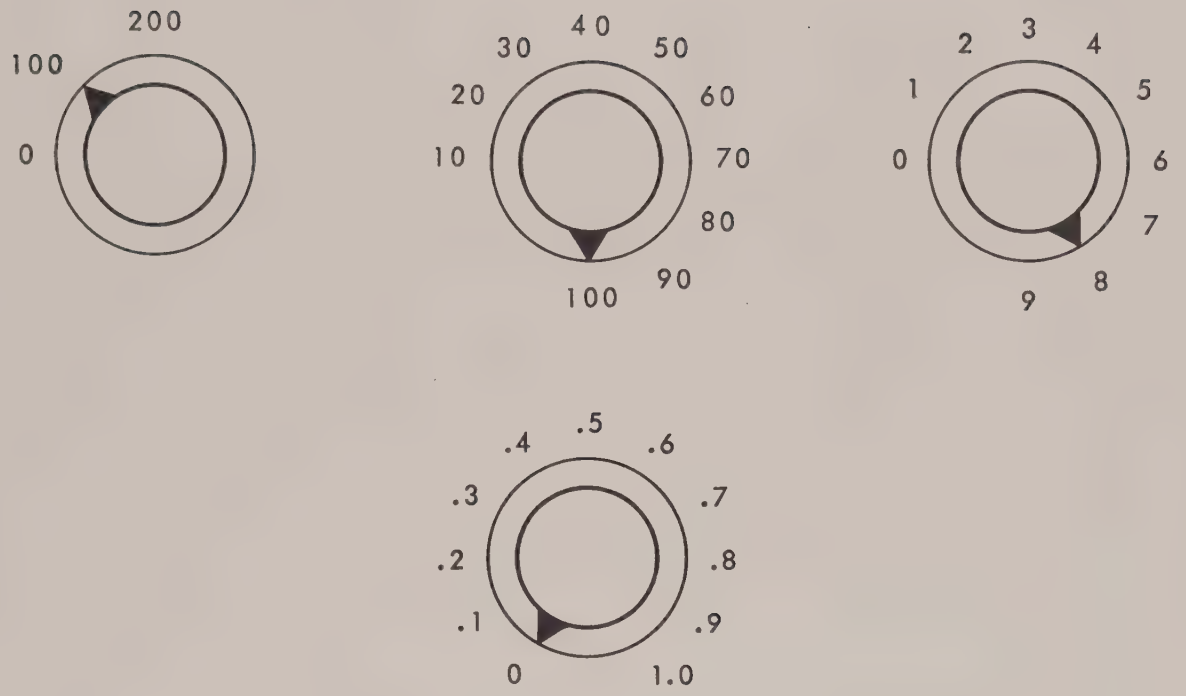


FIGURE 2.1

DIAL SETTING OF POWER SUPPLY WITH FOUR DIAL (VA) CONTROL FOR 208 VOLTS OUTPUT
THE OUTPUT OF THE THREE DIAL (VB) POWER SUPPLY IS SIMILARLY THE SUMMATION OF THE DIAL SETTINGS

GENERAL:

Temperature: This supply can operate only in the temperature range from 4 degrees C (39 degrees F) to 40 degrees C (104 degrees F), due to temperature limitations on the standard cell reference.

Failure to Operate: If the instructions have been followed, yet the supply fails to operate properly in approximately one minute, follow these steps:

1 If there appears to be a complete lack of power, check the instrument fuse and the 115-volt line source.

2 With the "DC" switch "OFF", voltage set to minimum, turn on the supply. The relay associated with the "DC" switch should close immediately. A few seconds later a small relay on the chopper amplifier strip should close. (Though not very loud, this relay can be heard when the cover is in place.) Approximately 45 seconds after being turned on, the time delay relay should close.

3 If this test fails to localize the fault, either refer to Section V, Maintenance, or contact the factory for further information.

SECTION III

DESCRIPTION OF CIRCUIT

The block diagram of Figure 3.1 shows the essential arrangement of a series-type voltage regulator. All amplifiers are lumped together and shown with a gain of (-)K. The minus sign denotes polarity change from input to output. The output voltage is divided down in order to secure a voltage which matches the reference voltage V. When the system is balanced, the attenuator applies a voltage +yE to the comparator and since V equals yE, there is no difference signal applied to the amplifier.

To describe the operation, assume the output E increases by an amount +e. Then a voltage y(E+e) is compared with V. The difference +ye is amplified and applied to the grid of the series tube. The increased bias reduces the current of the series tube, lowering the output voltage. In this manner the series tube acts as a wide range variable resistor. Thus, the action of the amplifiers is to reduce output voltage changes.

The KAY-LAB Absolute DC System employs a somewhat more complex arrangement in order to secure optimum performance over a wide range of frequencies.

The amplifier of Figure 3.2 has been divided into two amplifiers, each of which performs a specific job. Comparison of the fraction of the output (+yE) with the reference V is accomplished by connecting the standard cell as shown. Looking into the negative terminal of the cell, we see +yE minus the cell drop. Any difference between +yE and V is present here.

ACA:

It is not practical to build a direct-coupled amplifier in which the drift is equivalent to 10 microvolts or less at the input. In order to hold the output voltage E to better than 0.01%, it is not only necessary to have tremendous amplifier gain, but the equivalent input drift of the amplifier system should be approximately 25 microvolts or less. A good way of doing this is to make use of a mechanical convertor (chopper) to convert a DC voltage into pulsating DC which becomes AC after passage through a coupling capacitor. This AC signal may then be amplified by a capacitor-coupled amplifier which does not contribute appreciable DC drift.

The AC output of the amplifier is rectified and filtered. Rectification is accomplished by using the chopper as a clamp which once every cycle grounds the plate coupling capacitor of the last stage. A charge is added to or subtracted from the normal charge on this capacitor, depending upon the phase and amplitude of any signal voltage at the plate. This varying charge causes a pulsed DC voltage to be applied to the filter R3, C1, or R4 which removes the ripple. The phase of the amplifier is such that a positive input yields negative output and vice versa.

The ACA (AC Amplifier) of this power supply has from 86 to 90 DB gain for DC with an equivalent noise and drift of about 10 microvolts at the input.

GCP:

While the ACA provides high gain and low drift, it responds only to slow variations. This is due to the low operating frequency of the chopper and the large amount of filtering necessary at the output. A much faster amplifier is needed to secure good regulation against high frequency variations in E. This amplifier is further required to have high output voltage capabilities because of the wide range of E.

The GCP (General Coltrol Package) of this power supply system has approximately 66 DB gain for DC and 76 DB for nominal AC frequencies. Use of a balanced differential input stage and VR tube-regulated plus and minus supplies has resulted in an amplifier of unusually low drift. Power pentodes are used for the high level stages to secure high output voltage capabilities and good band width. Gain and phase corrective networks are employed to insure stability as well as good transient response under all conditions.

One advantage of the differential input system is the availability of two isolated input connections, one giving positive gain and the other negative gain. A capacitor (C2 of Figure 3.2) is used to couple AC variations of E into the negative input of the GCP. Thus, from very low to high frequencies the gain of the GCP acts to reduce these AC voltages. This is particularly important for reducing hum. The positive input is connected to the ACA output since the necessary phase inversion is accomplished in the ACA. For DC the total amplifier gain is the sum of the ACA and GCP gains.

ACA GAIN SWITCHING: In order to secure optimum response time at all output voltages, it is necessary to vary the gain of the amplifiers in accordance with the output voltage change. Referring to Figure 3.2, it is seen that changes in the output are attenuated by the ratio R1 (R1 + R2) before reaching the ACA input. Thus, the

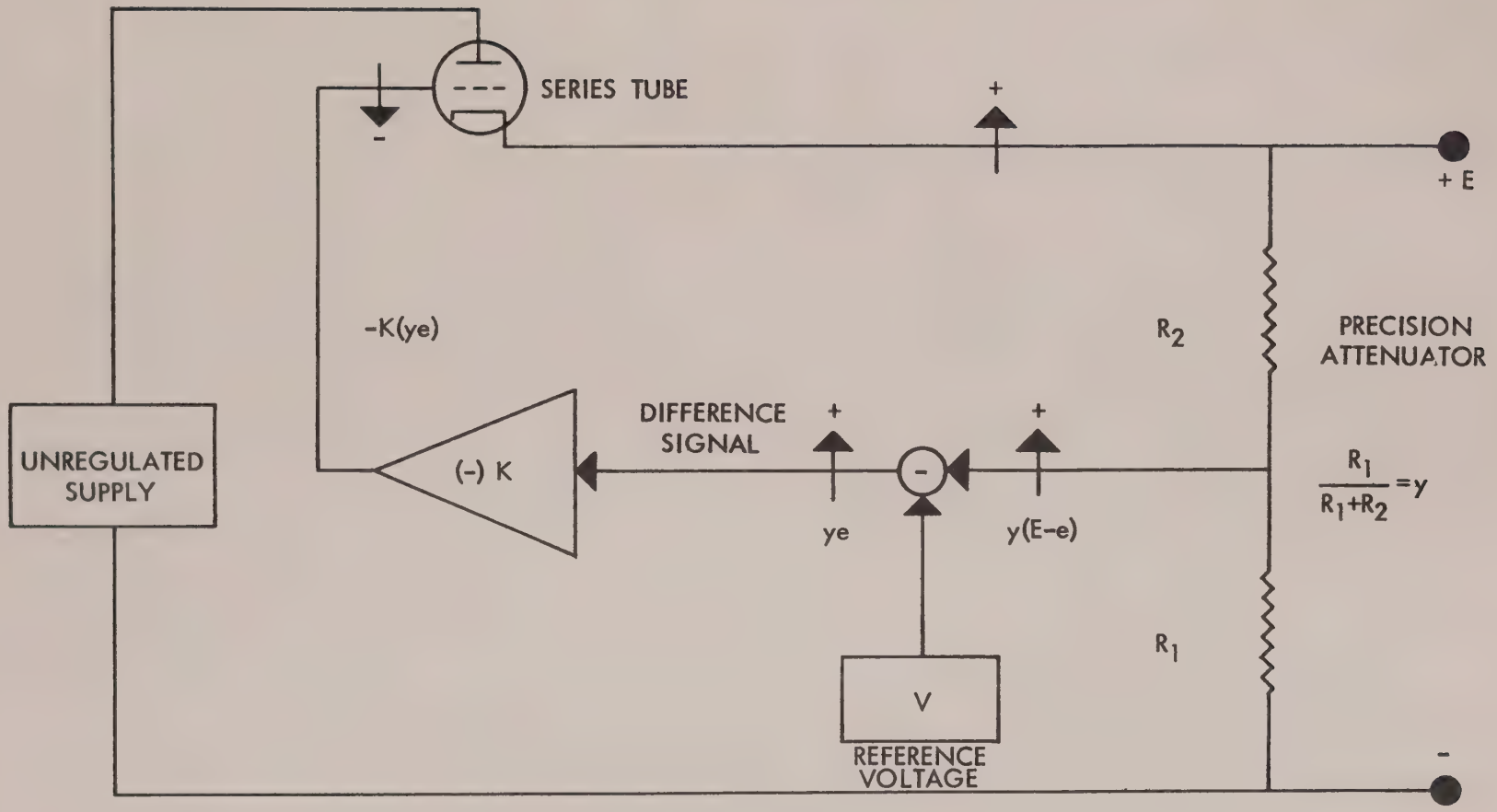


FIGURE 3.1
BLOCK DIAGRAM SHOWING ESSENTIAL ARRANGEMENT OF SERIES-TYPE VOLTAGE REGULATOR

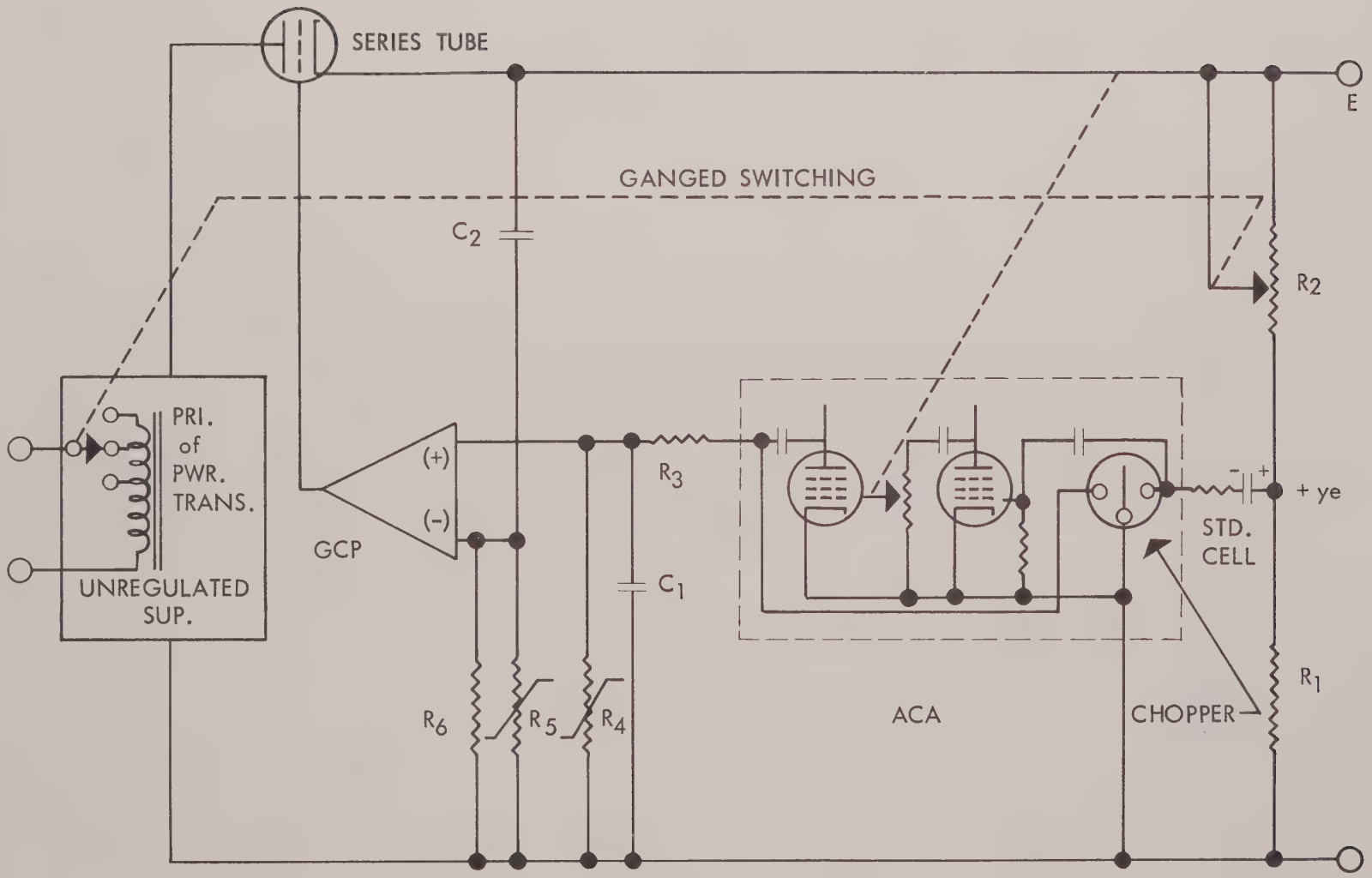


FIGURE 3.2
SERIES-TYPE VOLTAGE REGULATOR IN WHICH THE AMPLIFIERS HAVE BEEN DIVIDED INTO TWO AMPLIFIERS EACH OF WHICH PERFORMS A SPECIFIC JOB

precision attenuator acts as a gain control, effectively varying the gain of the system with changes in output voltage. In other words, the loop gain varies inversely with the output voltage. The response time of the system is dependent upon the loop gain as well as the circuit time constants. The effect upon loop gain caused by changes in the precision attenuator can be eliminated by inversely varying the gain of the ACA. If this were not done, it would be necessary to stabilize the system for the highest loop gain (i.e. lowest output voltage). This would cause the response to become progressively slower as the output voltage was increased.

In practice, the gain of the ACA is switched by means of a non-precision attenuator between the two amplifier stages. This gain control is ganged with the precision attenuator. Full gain is used at 100 volts and above. Below 100 volts the gain is switched down in the same ratio as E is changed, e.g. at 50 volts out the gain is down 6 DB. For fixed voltage supplies the ACA gain is fixed at the proper level.

NON-LINEAR FILTERS: There are two non-linear filters used in this system. By means of these filters very much faster response to severe transients, such as voltage changing, is obtained. One filter is R3, C1 and R4. The other is C2, R5, and R6. R4 and R5 are thyrite resistors which have the property of extremely high resistance at a fraction of a volt and quite low resistance above approximately 2 volts. Under steady-state conditions the voltage across these thyrites is very low. With these conditions it is necessary to have very long time constants for low hum and stable operation, but these long constants make a very sluggish system. When a severe transient occurs, the voltage rises across the thyrites and their resistance drops. Therefore, the time constants are sharply reduced during the period of the transient, resulting in fast recovery. As proper balance is approached, the time constants assume their normal high value.

UNREGULATED SUPPLIES: There are two unregulated supplies used. The one shown in Figures 3.1 and 3.2 is used to provide the output power and act as the plate supply for the final stage of the GCP. The primary of transformer in this supply is switched to accommodate large changes in output voltage.

There are three reasons for doing this. First, the series tube plate dissipation must be kept within rating at maximum output current. It is also necessary to keep the drop across the series tube within the maximum plate voltage rating. Thirdly, high plate voltage means high bias with undesirable low transconductance and very non-linear operation. This power switch is ganged to the 100's decade on the precision

attenuator. There is sufficient plate voltage and dissipation margin in the passing tube section to require only approximate adjustment of the unregulated voltage.

The other supply, not shown, is used to power the ACA and GCP. It is designated as the CPS (Control Power Supply). Voltage-regulator tubes are used with the GCP to reduce voltage variations and lower the power supply impedance.

PRECISION ATTENUATOR:

High-gain, low-drift amplifiers are not sufficient to hold the output voltage to a particular value. A stable, known reference voltage and an accurate attenuator must be employed. The standard cell used as the reference voltage is discussed below. The precision attenuator is used to obtain a fraction of the output voltage for comparison against the reference. The amplifiers act to reduce any possible difference. It is apparent that only the ratio of R2 to R1 determines the fraction of the output used for this comparison, and that the absolute value of R1 and R2 does not matter.

For convenience in manufacturing, however, the absolute value is maintained within approximately 0.1% of nominal value. In this supply a 1ma system is used in order to keep resistances at a moderate value and power in the attenuator at a very low level. The ratio of R2 to R1 can be varied by changing R1, R2 or both. In this supply only R2 is switched.

The following procedure is used at the factory in the manufacture of the attenuators. Large quantities of resistors, initially aged and trimmed to 0.1%, are given prolonged treatment to age them the equivalent of years of normal use. These resistors are periodically checked for stability of resistance, and an individual record is maintained on each. (To eliminate any possible effects of voltage co-efficient, all measurements are made with 1ma through the resistors to simulate actual usage.) Resistors which change too much or which show any unstable characteristics are discarded.

For 0.02% attenuators the resistors are first selected in groups which ratio within themselves to very close standards. Then the ratio of each resistor to others in the string is

measured (using the L & N No. 4395 Voltage Divider), and if necessary is series-trimmed with low-valued deposited carbon resistors for best match. The stability of the 1% trim resistors is more than sufficient for the purpose. These resistors never exceed approximately 0.1% of the resistors they trim. Hence, a 1% drift would result in a total resistor drift of only 0.001%. After assembly the unit is again checked. Where the tolerance is 0.02% or 5 millivolts, the accuracy is always within 0.01% or 3 millivolts.

STANDARD CELL:

The ultimate reference for the output voltage is the cell used as the internal voltage standard. The principal requirement of the standard cell is that its voltage remains constant under all conditions of normal operation. The voltage may be any value over a narrow range, since some adjustment is available (See Section IV, Standardization Adjustments) to match the attenuator to the specific voltage of the cell. This range is about 1 millivolt, and the cells used in this supply may have a voltage range from 1.0188 to 1.0198 absolute volts.

There are two types of mercury-cadmium standard cells, the normal or saturated, and the unsaturated cell. (The saturation refers to the concentration of cadmium sulphate in the electrolyte.) The normal cell has been adopted by the Bureau of Standards as the official standard of E.M.F. for this country. Although accurately known, the fairly high temperature co-efficient of these cells makes them inconvenient for instrument use. For this reason, the unsaturated cell is commonly used, and it is this cell which is used in the KAY LAB Absolute DC Power Supply.

Although not accurately known (except of course for measurements on the individual cell) the temperature coefficient of the unsaturated type is very low over a wide temperature range. Below 4 degrees C this cell saturates, and above 40 degrees C the temperature coefficient rises. There is one precaution which must be taken if a low temperature coefficient is to be maintained. It is essential that all parts of the cell be at the same temperature. To insure this, the cell is mounted in a heavy aluminum casting and insulated from it with felt. The high thermal conductivity of the aluminum reduces any temperature gradients to a very low value. The felt serves both as mechanical protection against shock and as a thermal filter to reduce rapid variations of cell temperature. By such means the variation of cell voltage can be kept below 0.005%.

Shaking, inversion, and temperature extremes received during shipment or storage can affect cell voltage more than 0.01%, although the change is seldom permanent except in

severe cases. The cells should not be stored for prolonged periods of time at temperatures below 4 degrees C or above 50 degrees C or in an inverted position. The cell will generally recover from ordinary shipping or handling within a few hours to 0.005% of its original voltage if maintained in a vertical position at room temperature.

SECTION IV

ADJUSTMENTS

HUM AND DC BALANCE

If at any time the total ripple and noise output of the supply exceeds 0.5 millivolts, as read on a Hewlett-Packard 400C or similar voltmeter, adjustments should be made to reduce this ripple. Failure to do so will cause no harm, but excessive hum and noise may indicate imminent tube or part failure which could cause damage.

The procedure is as follows:

1 Remove the cover portion of the cabinet.

2 Ground the "-" terminal of the supply and make measurements from the "-" terminal. On fixed-negative voltage supplies, the "+" terminal is grounded internally, hence DO NOT ground the "-" terminal also, but do make the DC measurement from the "-" terminal.

3 Adjust the output to approximately 100 volts (on variable voltage supplies). Allow to warm up approximately 5 minutes.

4 Use a DC vacuum-tube voltmeter having greater than 10-megohm input resistance and preferably one-volt full-scale sensitivity. Connect between the "-" terminal and the pin-jack test point which is available on top of the "GCP" chassis near the panel. (See parts placement drawing and Figure 4.1)

WARNING! DO NOT ADJUST THE POTENTIOMETER WHICH IS LOCATED WITHIN THE SHIELDED ATTENUATOR COMPARTMENT. THIS POTENTIOMETER IS FOR STANDARDIZATION OF THE INSTRUMENT AND ITS ADJUSTMENT IS COVERED LATER IN THIS SECTION.

5 Adjust the potentiometer P1 (R311 schematic) located near the pin-jack to obtain a zero voltage reading on the VTVM.

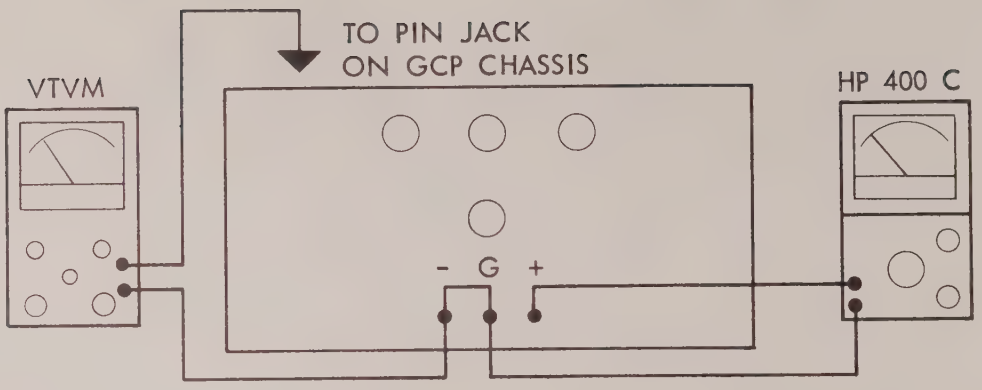


FIGURE 4.1
METER CONNECTIONS FOR HUM
AND DC BALANCE ADJUSTMENTS

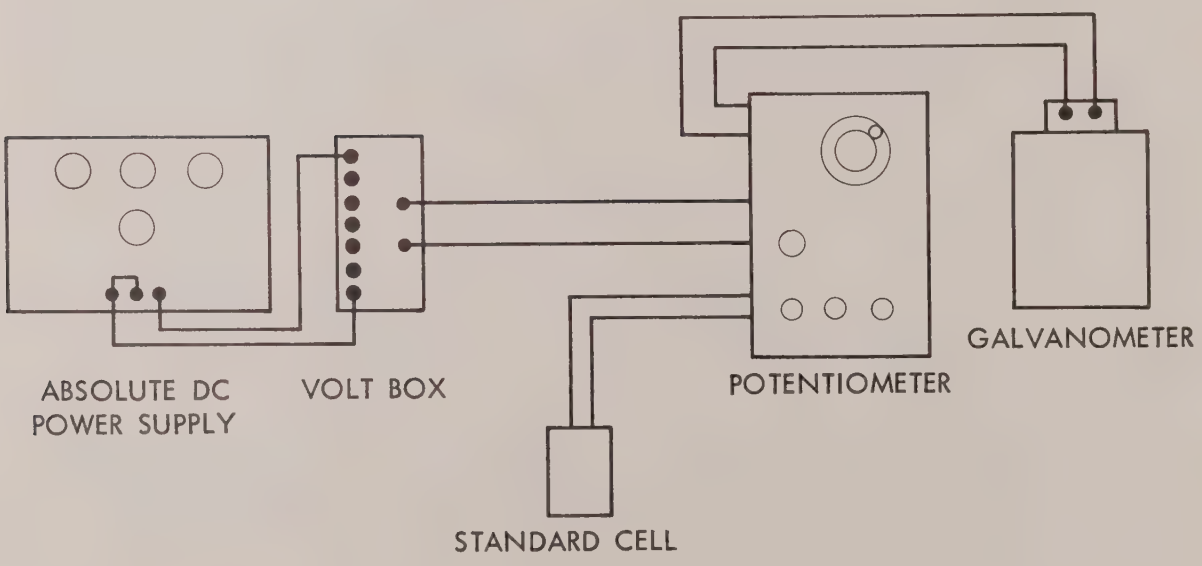


FIGURE 4.2
EQUIPMENT CONNECTIONS FOR STANDARDIZATION ADJUSTMENTS

6 Place a Hewlett-Packard 400C (or similar voltmeter) across the output terminals.

7 Adjust the potentiometer P2, which is located at the right side of the chassis on the "ACA" for minimum reading on the 400C. This reading should be 0.5 millivolts or less.

8 Replace the cover portion of the cabinet.

STANDARDIZATION ADJUSTMENTS

In cases where the users of KAY LAB Absolute Power Supplies maintain their own standards laboratory, they may desire to restandardize the power supply to agree with their own voltage standard. The accuracy of such standardization adjustments is dependent upon the equipment used for making the adjustments.

The following equipment is used at the factory for standardization:

Leeds & Northrup No. 7591 Volt Box
: This box has a guaranteed accuracy of 0.04%; however, the unit used at the factory has been calibrated against a Leeds & Northrup No. 4395 Voltage Divider whose guaranteed ratio accuracy is 0.001%.

Leeds & Northrup No. 7552 Potentiometer having a guaranteed accuracy of 0.01%.

Leeds & Northrup No. 2430 Galvanometer

Eppley Standard Cell
: Laboratory reference voltage, which is periodically checked against a bank of normal cells whose sole purpose is to check the cell actually used. All of the cells are periodically certified by the U. S. National Bureau of Standards.

The method is illustrated in Figure 4.2.

The following procedure should be used when making the standardization adjustment.

1 Remove the cover of the power supply and locate the standard voltage adjust potentiometer R402. This potentiometer is located in the shielded standard cell and attenuator compartment (See parts placement drawing).

2 Proceed first as directed under Hum and DC Balance above. When these adjustments are completed, remove the voltmeters but leave the "-" terminal connected as described in Step 2, Hum and DC Balance.

3 Connect equipment as shown in Figure 4.2. The volt box (or similar divider) is necessary in order to standardize at the recommended voltage.

4 For fixed-voltage supplies, set the measuring equipment to read the rated voltage of the supply. Adjust R402 SLOWLY until the proper voltage is obtained.

5 For variable supplies, set to approximately 100 volts, with the 100's dial and the variable potentiometer set to zero. Adjust R402 SLOWLY until the indicated voltage is obtained.

6 Switch 10's dial (and on VA models the 1's dial) to minimum, the 100's dial to 100, and measure the output. Also measure all steps of the 100's dial in the same manner.

7 Examine the values obtained in steps (5) and (6). It may be seen that a new adjustment of R402 will yield a better mean accuracy. If so, reset and again measure voltages to check.

8 When the best adjustment of R402 has been made, it may be desirable to check individual steps on the 10's dial (and 1's on VA models). Switch the 100's dial to zero, then proceed with measurement.

9 To reset the knob on the variable voltage potentiometer, rotate slowly counter-clockwise only until the voltage stops changing. Set pointer on knob at zero mark. (See Section 1, Specifications, Voltage Range, on potentiometer accuracy.)

LOAD CHECK

The change in output voltage with load is so small as to be negligible. (See Section 1, Specifications, Output Impedance.) The internal resistance of the supply is approximately as great as a #18 copper wire connected between the terminals. From this it may be seen that with ordinary connection means, the resistance of the joint and lead is much higher than the resistance of the supply. If the change in voltage due to supply resistance alone is to be measured, it is necessary to arrange the connections so that their resistance is added to the load and not to the supply. If the connections are made as shown in Figure 4.3, the actual impedance of the supply plus that of the terminals may be measured.

FACTORY CALIBRATION PROCEDURE

The procedure used at the factory for standardization is essentially as listed above but more extensive. In addition to the initial set-up and check points, the calibration is checked for positive as well as negative terminal on ground. The voltage is checked under maximum load current at both minimum and maximum voltage and positive or nega-

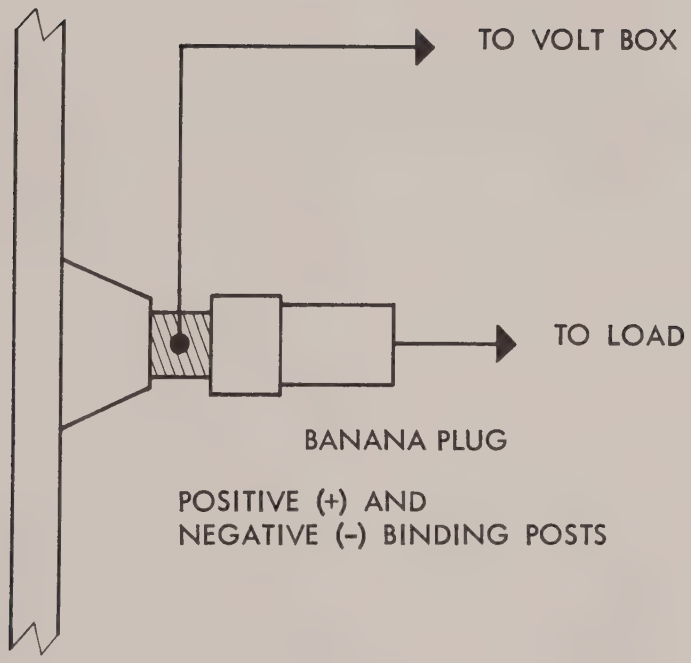


FIGURE 4.3
CONNECTIONS TO BINDING POST FOR MEASURING THE ACTUAL IMPEDANCE OF THE SUPPLY PLUS THE IMPEDANCE OF THE TERMINALS

tive grounded. The variation of voltage with ± 10% line voltage at maximum and minimum output is also checked. Unless there is reason to suspect faulty operation, such extensive tests need not be repeated.

NOTES ON THE PRECISION ATTENUATOR

WARNING! Under no circumstances should the precision attenuator be tampered with except under factory direction. Any unauthorized work on the attenuator will void accuracy guarantees. The only adjustment permitted is R402, as directed in Standardization Adjustments above.

The accuracy of the supply is directly dependent upon the attenuator used, as all supplies incorporate a standard cell and the same amplifiers. It is not practical to make resistor changes in the attenuator without disconnecting certain leads and using equipment such as a Leeds & Northrup No. 4395 Voltage Divider (0.001% ratio accuracy) to determine the ratio of the substituted resistor to the remainder of the string. It is well to note that only the ratio of the resistors to each other determines the output voltage.

SECTION V

MAINTENANCE

OSCILLOSCOPE AND VOLTMETER CHECK

If the maximum capabilities of this instrument are to be realized, it is advisable to make an occasional performance check. This is best done with a sensitive scope and a wide-band voltmeter having a 1-millivolt full-scale sensitivity applied to the output terminal.

First, note the hum level. If it exceeds 0.5 millivolts, then proceed as directed in Section IV, Hum and DC Balance.

For variable voltage supplies, try 100 volt changes in output (unloaded). If the supply requires longer than approximately 3 seconds to recover, low gain is indicated.

CALIBRATION CHECK

A calibration check is not recommended as a means of trouble shooting since defects must be very severe before the calibration is materially affected. If the calibration is checked, first determine the performance of the supply as outlined in Oscilloscope and Voltmeter Check above. Make any necessary adjustments or repairs, then proceed as directed in Section IV, Standardization.

TUBE REPLACEMENT

Any tubes with standard RTMA characteristics may be used for replacement. The only tube substitutions allowable are premium or ruggedized versions having identical characteristics of the RTMA type. Some selection of V101 may have to be made. If the hum will not balance down well (See Section IV, Hum and DC Balance), or if the system seems quite microphonic, try another tube for V101.

TROUBLE SHOOTING

The following list of symptoms, possible causes, and remedies will be useful in locating faults.

SYMPTOMS	CAUSES	REMEDIES
Instrument Inoperative	Blown fuse.	Check for short, repair, then replace with fuse of proper size.
	Open power cable or plug.	Repair or replace defective piece.
	Defective tube(s). Check rectifiers and series tubes first.	Replace defective tubes (See Tube Replacement)
	Defective relay. Check operation of time delay relay K502 and associated Amperite time delay K501 first. Delay should be approximately 45 secs.	Replace Amperite tube.
	Defective "DC" switch. Relay K401 should be non-energized when "DC" is switched on.	Replace switch S402.
	Short circuit in capacitor C403.	Replace capacitor.
	Defective relay K101 in ACA.	Repair or replace relay.
	Defective capacitor C304.	Replace with exact duplicate.
Instrument Inoperative High output voltage unaffected by controls.	Defective tube. Check 6AG7 (V302) first for short circuit or other fault.	Replace defective tube.
	Shorted capacitor C401 + 150 voltage low.	Replace C401 and R407.
	Open precision attenuator.	Contact factory
Instrument Inoperative Output voltage drifts over wide range at slow or moderate rate, does not respond to controls, may drift high or low and remain there.	Defective ACA. Check relay K101 and tubes.	Repair or replace defective parts.

SYMPTOMS	CAUSES	REMEDIES
Instrument Operative, but noisy and unstable.	Defective tubes. Check V101 and V301 first by substituting new tubes.	Replace noisy tubes.
	Defective capacitor C304.	Replace with exact duplicate.

TUBE VOLTAGE CHART FOR ACA, CPS AND GCP

Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9	Cap
V101	—1.3**	0	fil.	fil.	+75	+40	0			
V102	—1.2**	0	fil.	fil.	+75	+40	0			
V201	NC	+425	NC	375 RMS	NC	375 RMS	NC	+425		
V202	NC	+19	NC	45 RMS	NC	45 RMS	NC	+19		
V301	+80	0	+1.4	fil.	fil.	+90	0	+1.4	fil.	
V302	0	fil.	NC	—5	0	+150	fil.	+120		
V303	NC	fil.	—180	NC	—190	NC	fil.	—0.2		* see note
V304	NC	fil.	—180	NC	—190	NC	fil.	—120		—1.5
V305	+150	0	NC	0	+150	NC	0			
V306	0	—150	NC	—150	0	NC	—150			
V307	—150	—300	NC	—300	—150	NC	—300			

* The plate cap of V303 is connected to the grid of the passing tubes. Its voltage is dependent upon the output voltage and current of the supply but generally is approximately 50 to 100 volts below the cathode voltage of the passing tube.

** Measured with 100-megohm VTVM.

AC voltages measured to ground with a 1000-ohm per volt VOM. DC voltages measured to ground with a VTVM.

All measurements made with negative side of supply connected to ground.

All voltages are subject to approximately 25% variation, depending upon particular tubes, parts, line voltage, and output voltage and current of the supply.

PARTS LIST

CONTROL POWER SUPPLY
SUB- ASSEMBLY
(Job #122)

CAPACITORS	KAY LAB PART NO.
C201 40/40mfd 500V Electro Can w/Ins. Tubes	51144
C202 40/40mfd 500V Electro Can w/Ins. Tubes	51144

TUBES

V201 5V4G	702723
V202 5Y3GT	702726

MISCELLANEOUS

L201 Choke Triad #14372	673683
L202 Choke Triad #14372	67383
T201 Transformer Traid #7644	653651

PARTS LIST

GENERAL CONTROL PACKAGE SUB-ASSEMBLY
(Job #118)

RESISTORS		KAY LAB PART NO.
R301	20K 10w	512060
R302	15K 10w	512057
R303	15K 20w	512102
R304	180K ½w	411348
R305	560K ½w	411354
R306	4.7meg ½w	411365
R307	8.2K ½w	411332
R308	2K 20w	512091
R309	5.6K 1w	431560
R310	12K 1w	431564
R311	10K A-47 Pot. No Shaft	501865
R312	1.5meg ½w	411359
R313	4.7meg ½w	411365
R314	25K 10w	512062
R315	6.8K ½w	411331
R316	470K ½w	411353
R317	220K ½w	411349
R318	-	
R319	27K 1w	431568
R320	27K 1w	431568
R321	10K 1w	431563
R322	2K 20w	512091
R323	1.2K ½w	411322
R324	220K 1w	431579
R325	180K ½w	411348
R326	56ohm ½w	411306
R327	100ohm ½w	411309

CAPACITORS		KAY LAB PART NO.
C301	.05mfd 400V Paper	81247
C302	.05mfd 400V Paper	81247
C303	.05mfd 400V Paper	81247
C304	.1mfd 600V Mylar 620	65215
C305	.02mfd Ceramic Disc	41058
C306	.05mfd 600V Paper	81265
C307	.02mfd Ceramic Disc	41058
C308	-	
C309	500mmf Ceramic Disc	41039
C310	.05mfd 400V Paper	81247

TUBES		
V301	5751	732812
V302	6AG7	702731
V303	6BG6G	702759
V304	6BG6G	702759
V305	0A2	732792
V306	0A2	732792
V307	0A2	732792

MISCELLANEOUS		
RT301	Thyrite Globar BNR 432488	494225
TP301	Nylon Tip Jack	174119

PARTS LIST

A C AMPLIFIER SUB-ASSEMBLY
(Job No. 117)

RESISTORS	KAY LAB PART NO.
R101 100K 1w	431575
R102 100K 1w	431575
R103 100K 1w	431575
R104 100K 1w	431575
R105 100K 1/2w	411345
R106 33K 1/2w	411339
R107 1meg 1/2w	411357
R108 220K 1/2w	411349
R109 3.3meg 1/2w	411363
R110 8.2meg 1/2w	411368
R111 1meg 1/2w	411357
R112 3.3meg 1/2w	411363
R113 56K 1/2w	411342
R114 10meg 1/2w	411369
R115 100Ω 2w Pot. A-43	
No shaft	501890
R116 -	
R117 -	
R118 10K 1/2w	411333

CAPACITORS	KAY LAB PART NO.
C101 8mfd 500V Electro Tube	51103
C102 .1mfd 400V Paper	81248
C103 .1mfd 400V Paper	81248
C104 300mmf Ceramic Disc	41032
C105 .1mfd 400V Paper	81248
C106 .1mfd 400V Paper	81248
C107 300 mmf Ceramic Disc	41032
C108 .005mfd Ceramic Disc	41054
C109 1mfd 200V Metalite	61219

TUBES	
V101 6AU6	702748
V102 6AU6	702748

MISCELLANEOUS

BT101	Bias Cell Mallory	184158
D101	Brown Converter	633873
K101	Leach Relay SPDT 223P	371285
RT101	Thyrite Globar 432 BNR 18	494225

PARTS LIST

UNREGULATED SECTION

Models 30B-100, 30C-100, 30F-100

RESISTORS

R501	4K 25w
R502	25K 20w
R503	1K
R504	100 ohms 5w
R505	100 ohms 5w
R506	1K
R507	1K
R508	100 ohms 5w
R509	100 ohms 5w
R510	1K
R511	1K
R512	100 ohms 5w
R513	100 ohms 5w
R514	1K
R515	1K
R516	100 ohms 5w
R517	100 ohms 5w
R518	1K
R519	1K
R520	100 ohms 5w
R521	100 ohms 5w
R522	1K
R523	25K 10w
R524	4K 25w
R525	15K 10w
R526	390 ohms 1w

CHOKE

L501	Swinging choke 1.5 to 7.5 henries at 1125ma max.

CAPACITORS

C501	80mfd-80mfd 300 volt metal can electrolytic with cardboard insulating tube
C502	80mfd-80mfd 300 volt metal can electrolytic with cardboard insulating tube
C504	80mfd-80mfd 300 volt metal can electrolytic with cardboard insulating tube
C505	80mfd-80mfd 300 volt metal can electrolytic with cardboard insulating tube

TUBES

V501	866AX
V502	866AX
V503	6336
V504	6336
V505	6336
V506	6336
V507	6336

TRANSFORMERS

T501	Plate transformer, primary tapped to give 524, 770, 1020vct at 1125ma
T502	Filament transformer 2.5v-15a, 6.3v-25a, 6.3vct-10a

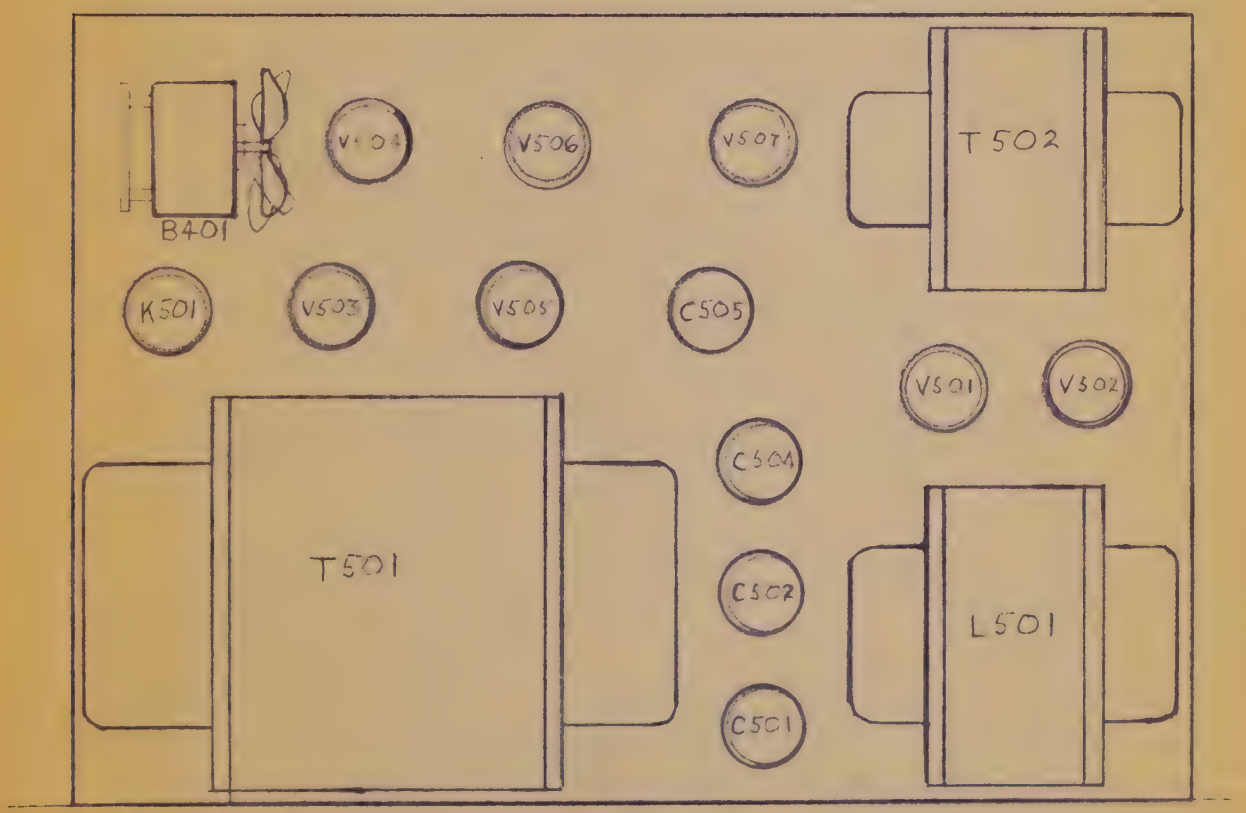
MISCELLANEOUS

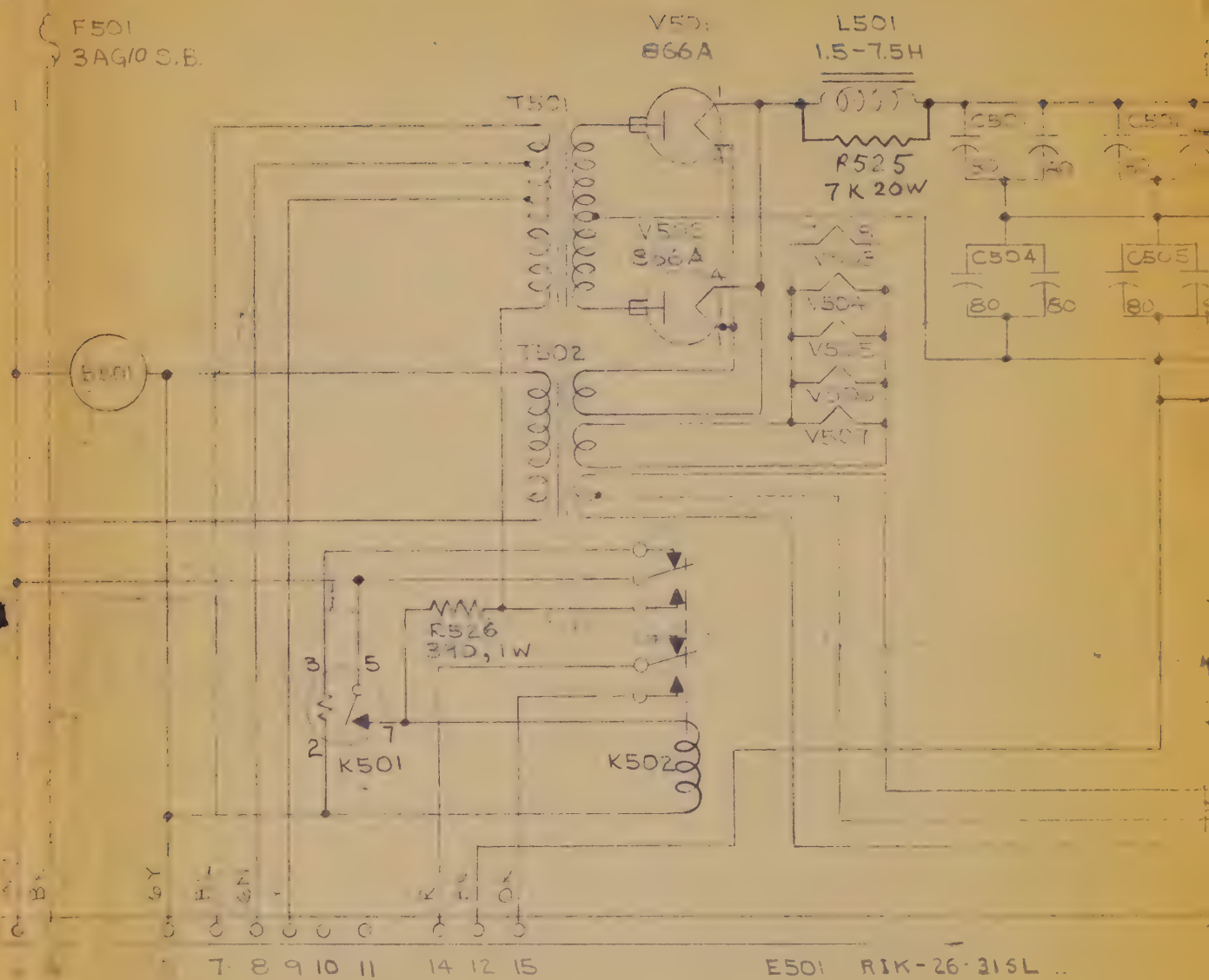
K501 Relay, time delay, Amperite #115NO45

K502 Relay, DPDT, 115VAC, Leach #1127

B501 Fan motor, Barber-Coleman #DYAB
Blade , " " #DYAR
Bushing, " " #YAR

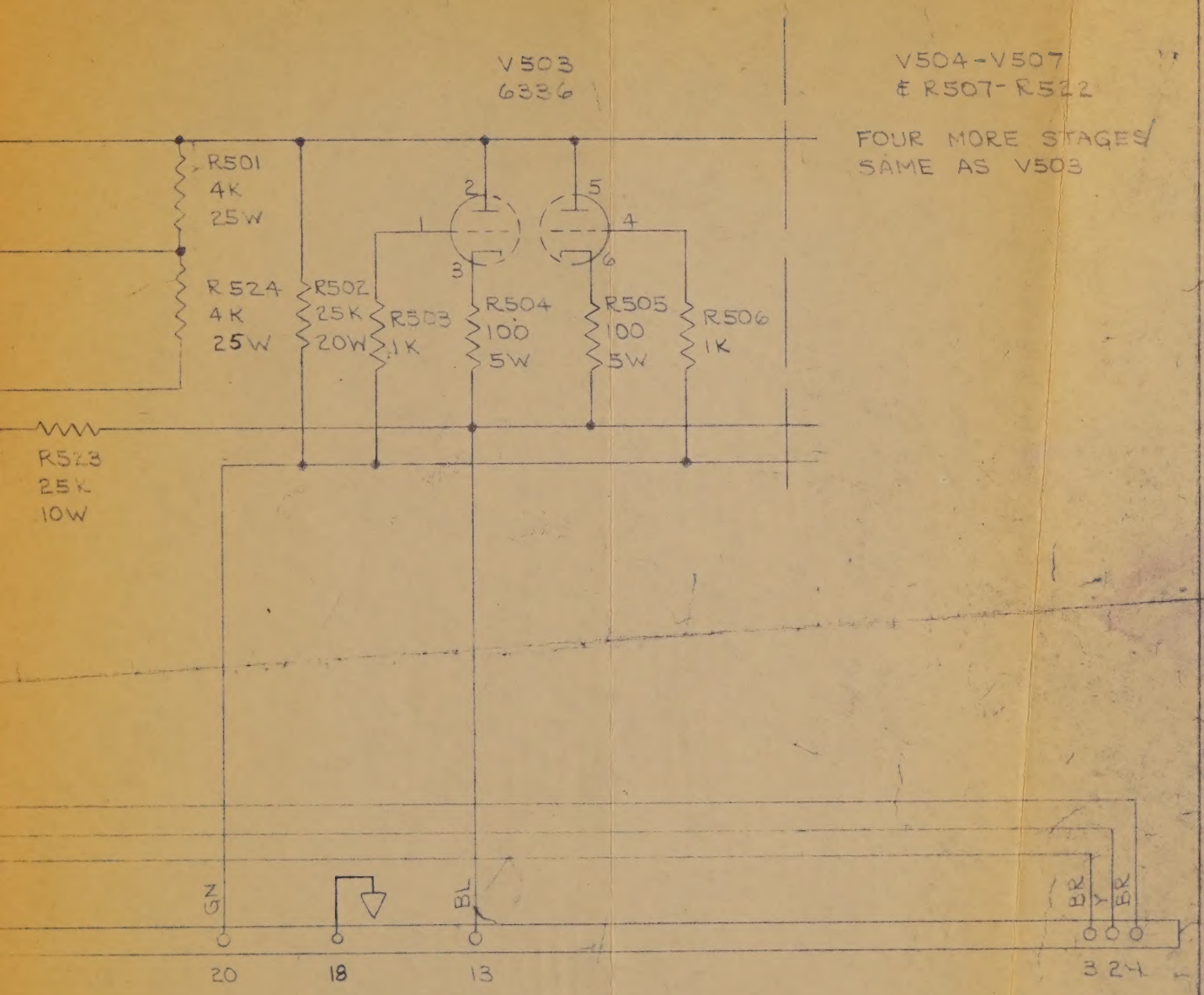
NOTE: All resistors 1/2 watt unless otherwise specified.


B401
V504
V506
V507
T502
K501
V503
V505
C505
V501
V502
C504
T501
C502
L501
C501



	F	R525 WAS 15K, 10W; EFF. SN 2865, 2866, 2867 & 8-9 & ON	12-6-56	E.O. 10038
	E	C503 CECH DELETED	2-17-56	EO 532
	D	V501, V502 CHANGE TO 249P	12-23-55	EO 1-
	C	ADD R525	7/1/54	P.O.
	B	ADD E501-18 & CND	5-28-54	PCW
	A	CHG K501, ADD [illegible] & R524	5-3-54	[illegible]

ITEM	PART NO	
5	K502	RELAY
4	[illegible]	TR[illegible]
		6.3 V.
3	T501	TRANS
	[illegible]	524, 7
2	K501	RELAY,
1	B501	MOTOR,



D.P.D.T., 115 VAC COIL LEACH # 1127
RMER, FILAMENT, 2.5V-15A., 6.3V-25A.,
T. -10A.
RMER, PLATE, PRIMARY TAPPED TO GIVE
OR, 1020 V.C.T. AT 1125 MA.
IME DELAY, AMPERITE 115N045
AN
DESCRIPTION

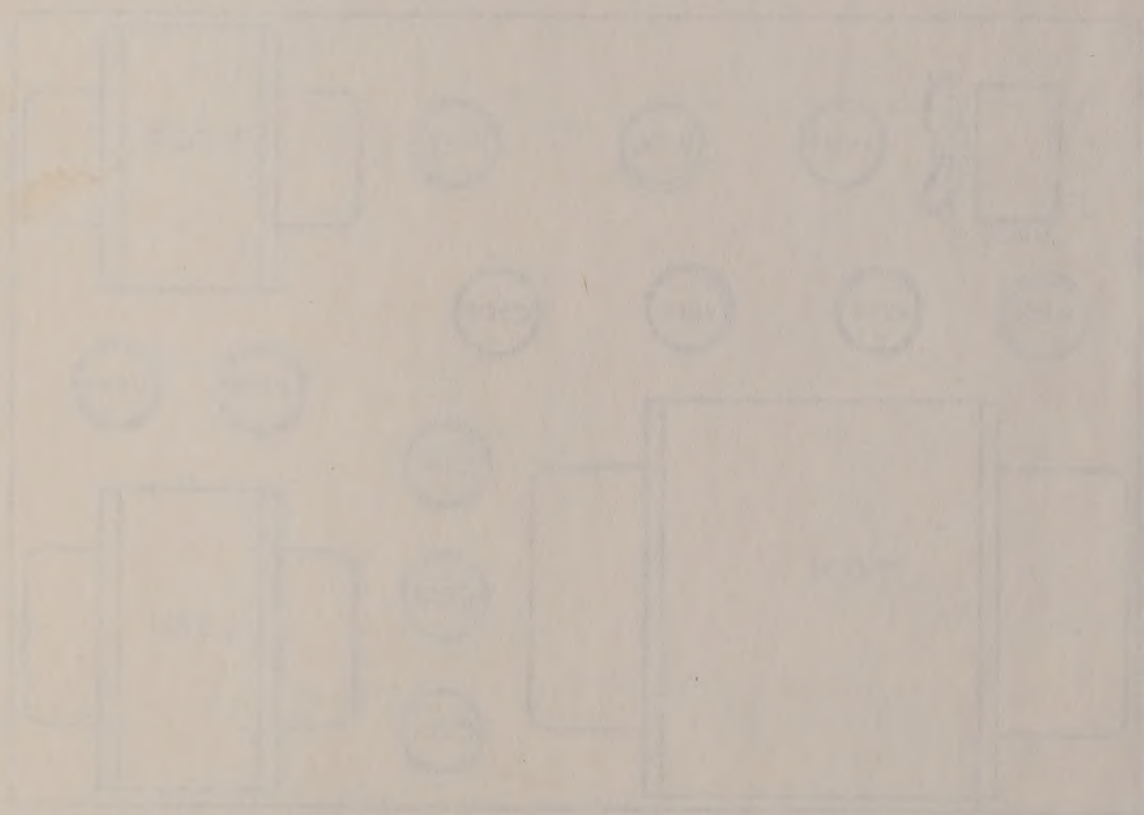
KAY-LAB MODEL 30C100 & 30F100 ABSOLUTE D.C. POWER SUPPLY - POWER SCHEMATIC

ENGINEER — KEL	DRAWN BY — L.W.
DATE — 12-29-53	CHECKED BY — KHP
SCALE —	DRAWING NO. 9803910

KALBFELL LABORATORIES INC.
1090 MORENA BLVD. SAN DIEGO 10, CALIF.

B-42-2

9803910 B-42-2



CF-200R - SN3356 N-2640